

GPM

Global Precipitation Measurement Advanced Study Plan (FYxx)

[Document Date]

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GLOBAL PRECIPITATION MEASUREMENT ADVANCED STUDY PLAN For Fiscal Year xxxx

I SCOPE

This Advanced Study Plan for the Global Precipitation Measurement (GPM) mission defines the tasks to be performed by the Goddard study team during fiscal year xxxx (FY xx). The purpose and summary of the plan is discussed in the following section, followed by details of the proposed tasks.

II PURPOSE & SUMMARY

This plan defines the work to be performed in FY xx and the funds budgeted against that work. It defines the scope of the work, the principle participating and support organizations, and the deliverable product(s) resulting from each task.

STUDY GOALS

The advanced studies to be performed explore the mission science requirements and the implementation options to meet those requirements. The goals of these studies are to:

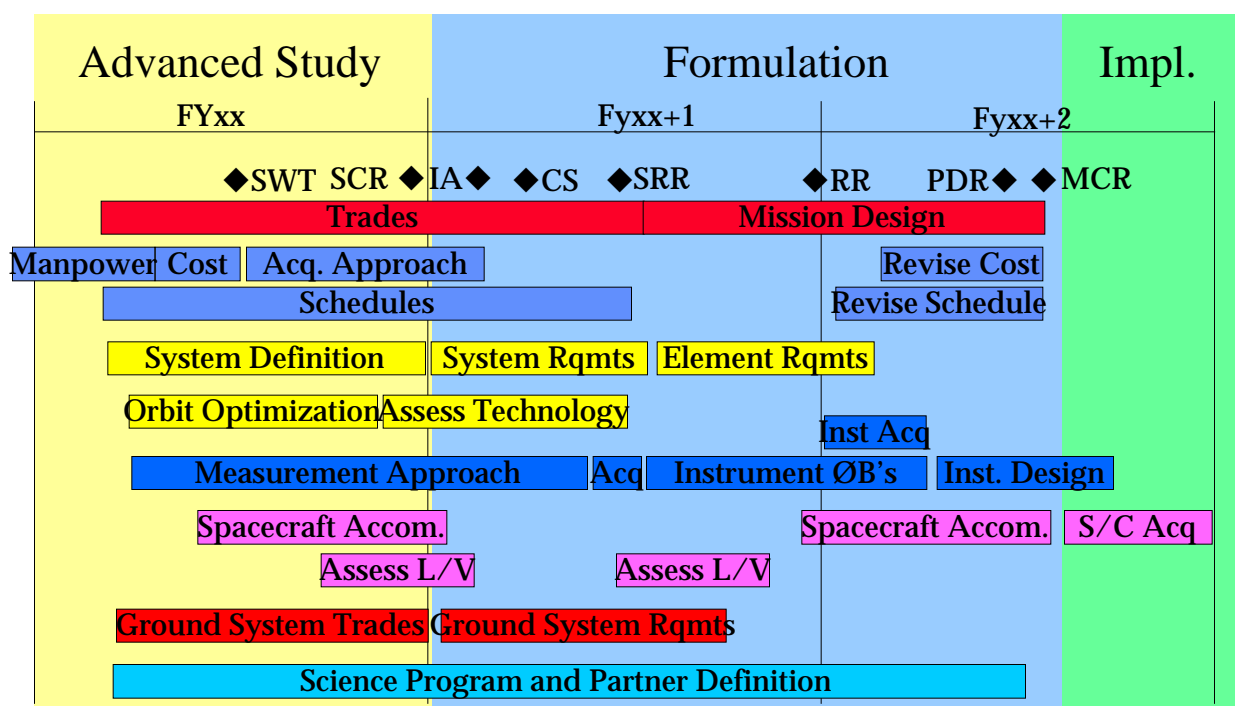
1. Define the science and mission requirements (Tasks A & C)
2. Conduct a Technology Readiness Assessment (Task E)
3. Explore the initial trade space both for the mission architecture and the measurement approach (Tasks C & D)
4. Assure NASA mission lessons learned are incorporated into the mission formulation phase (Task C)
5. Set the framework for establishing international partnerships and conduct a partnership assessment (Task B)
6. Develop a set of potential acquisition approaches (Task F)
7. Establish a preliminary set of mission plans which will encompass strategies for schedules, reserves and policy compliance (e.g. environmental impact, debris and disposal) (Task F)
8. Prepare for an Independent Assessment in 1Q FY xx+1 (Task F)

GUIDANCE

The GSFC advanced study team will work with the NASA HQ team in a cooperative effort to accomplish the goals above. The team will coordinate by TELECON once per week, produce monthly status reports and prepare for a status review in the [xxx] timeframe.

Figure 1 is an overview of the advanced study period and shows the transition through formulation to the start of implementation.

FIGURE 1 GPM DEVELOPMENT PHASE PLAN



Milestone Abbreviations:

SWT - Science Working Team
SCR - System Concept Review
IA - Independent Assessment
CS - Concept Selection

SRR - System Requirements Review
RR - Receiving Review
PDR - Preliminary Design Review
MCR - Mission Confirmation Review

Mission
Project
Systems
Measurement
Spacecraft
Gnd/Data Sys.
Science

DELIVERABLES

This effort will produce:

- Preliminary Science Requirements (Draft June, Revision 1 September)
- A draft set of Level 1 Requirements (Draft June, Revision 1 September)
- A Partnership/Planning Workshop (May)
- Mission Architecture and Trade Analyses (Initial Definition May, Complete August)

BUDGET

The budget for the GPM Advanced Studies allocates the \$xx budget to six task areas:

TASK	TITLE	COST (\$K)	CS FTE	SSC FTE	GOALS
A	Defining Science Requirements	xx	0.9		1
B	Outreach and Partnership	xx	0.5	0.4	5
C	Defining Mission Architecture	xx	2.8	1.5	3 & 4
D	Defining the Measurement Approach	xx	1.0	0.6	3
E	Defining the Technologies	xx		0.6	2
F	Programmatic & Administrative	xx	1.0	0.4	6, 7 & 8
	TOTAL	xx			

The funding plan is shown in Table 1. Details of each task and sub-task are presented in the following sections.

TABLE 1. PRELIMINARY GPM ADVANCED STUDY FUNDING PLAN

		GLOBAL PRECIPITATION MISSION FYXX											
		FYxx PHASING											
		(\$*K)											
		<u>12/1/</u>	<u>1/1/</u>	<u>2/1/</u>	<u>3/1/</u>	<u>4/1/</u>	<u>5/1/</u>	<u>6/1/</u>	<u>7/1/</u>	<u>8/1/</u>	<u>9/1/</u>	<u>C/O</u>	
Req. funding profile	506/NOA	Mon.											
		Cum.	0	0	0	0	0	0	0	0	0	0	
Required Commitments		Mon.	0									0	
		Cum.	0	0	0	0	0	0	0	0	0	0	
Required Obligations		Mon.	0									0	
		Cum.	0	0	0	0	0	0	0	0	0	0	
Required Cost		Mon.	SAMPLE FORMAT									0	
		Cum.	0	0	0	0	0	0	0	0	0	0	
<u>Expected Cost Details:</u>		<u>Total</u>	<u>12/1/</u>	<u>1/1/</u>	<u>2/1/</u>	<u>3/1/</u>	<u>4/1/</u>	<u>5/1/</u>	<u>6/1/</u>	<u>7/1/</u>	<u>8/1/</u>	<u>9/1/</u>	<u>C/O</u>
<i>Defining Science Rqmts:</i>		0											
Science Rqts Dvt/Grants		0											
<i>Outreach & Partnership</i>		0											
Planning Workshop		0											
Informational Video		0											
<i>Defining Mission Arch.</i>													
Orbit Optimization/Model													
System Engineer													
IMDC		0											
PDC costs		0											
Ground/Data System Studies		0											
Operations Concept Studies		0											
<i>Defining Meas. Approach</i>		0											
JPL Support		0											
<i>Defining Technologies</i>		0											
ISAL Studies		0											
JPL Support		0											
<i>Programmatics & Admin.</i>													
Taxes													
Admin. support													
Tools/ADP													
Project Planning		0											

WORKFORCE

The GPM advanced Study effort will be staffed by civil servants, JPL support staff and support services contractors. Table 2 lists the required skills, an estimate of the time to be applied in “Full Time Equivalent” (FTE) work-years and the primary task each person will be assigned to.

TABLE 2. GPM ADVANCED STUDIES WORKFORCE ESTIMATE

Skill Type	FTE	Task	Source
Project Formulation Manager	1.0	All	GSFC/700.1
Project Scientist	0.8	A. Science Requirements	GSFC/912
Project Science Support	0.1	A. Science Requirements	GSFC/913
Administration Support	0.8	B/F. Outreach/Admin	GSFC/PAAC
Lead System Engineer	0.7	C. Mission Arch.	GSFC/730
Support System Engineer	1.5	C. Mission Arch.	GSFC/MEDS
Flight Dynamics Engineer	1.5	C. Mission Arch.	GSFC/572
Ground System Engineer	0.3	C. Mission Arch.	GSFC/581
Data System Engineer	0.3	C. Mission Arch.	GSFC/902
Instrument Manager	0.75	D. Meas. Approach	GSFC/740
Instrument System Engineer	0.25	D. Meas. Approach	GSFC/730
Radar System Engineering	0.6	D. Meas. Approach	JPL
Technology & System Support	0.6	E. Technology	JPL
Resource Analyst	0.5	F. Programmatic & Admin.	GSFC/400.1
TOTAL	9.7		

III TASKS

The tasks discussed in this section include Defining the Science Requirements, encouraging Outreach & Partnership, Defining the Mission Architecture, Defining the Measurement Approach, performing Technology Studies, and Administrative and Miscellaneous Support. Each task definition includes an overview of the work to be performed, the budget suballocation, and the schedule for performance. The summary schedule for the one-year activities is shown in Figure 2.

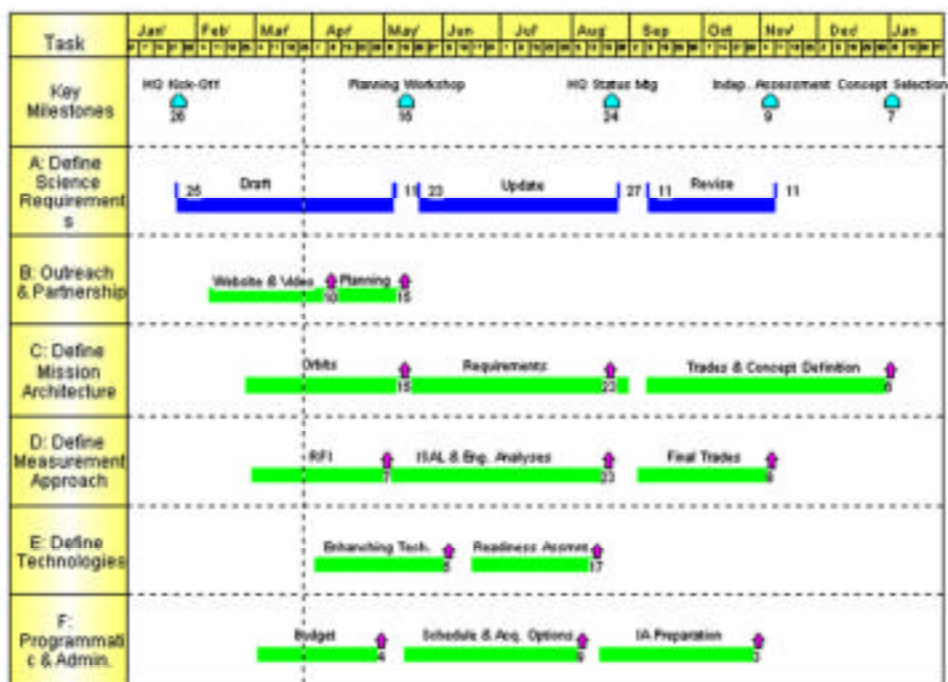


FIGURE 2. GPM ADVANCED STUDIES SCHEDULE FOR FY XX

A. DEFINING SCIENCE REQUIREMENTS

The pre-eminent task for the advanced study effort is to define the mission science requirements. This effort comprises nine funded and unfunded subtasks, as shown in Table 3. The schedule dates assume work starts in January 'xx.

The \$xxk planned for this task is distributed over nine subtasks as detailed in the following paragraphs. Note; sub-task 9 has been deleted and combined with the Outreach and Partnership Task (B), described later in this document.

TABLE 3. DEFINING SCIENCE REQUIREMENTS

Subtask	Sub-allocation (k)	Completion Date
1 Develop Radiometer Simulator		9/30
2 Develop Radar Simulator		9/30
3 Science Measurement Validation Planning		8/31
4 Cloud Radiation Simulation		8/31
5 Atmospheric Simulation & Requirements		8/31
6 Climate Change Detection		8/31
8 Ocean Science Requirements		3/31
7 Hydrology Requirements		3/31
9 Deleted		
10 Science Workshops & Publications		8/31
SCIENCE TASK TOTAL		

Subtask A.1 Develop Radiometer Simulator

A computer model will be developed to simulate the performance and data characteristics of a radiometer, emulate the latest developing technologies, and assess the various measurement approaches considered during the GPM advanced study, formulation, development, and operation periods. An interim status of the model will be available at the end of May to support the architecture work under Task 2, and the simulator will be completed by the end of September. \$xxx has been allocated to complete this subtask. It is planned that this activity will be conducted via a grant to [university]. A brief study plan from the university is available.

The simulator will consist of a standardized set of radiometer performance parameters along with a defined suite of environmental cases (e.g. drizzle, storm, etc), to which can be added the performance (e.g. channels, spatial resolution, receiver noise factor, etc) of a radiometer under consideration. The output will be a figure of merit of the rain retrieval effectiveness for the radiometer under consideration.

Subtask A.2 Develop Radar Simulator

A computer model will be developed to simulate the performance and data characteristics of a standard dual frequency rain radar to model the latest developing technologies and assess the various measurement approaches. The simulator will be completed by the end of September. \$xxx has been allocated to complete this subtask.. This activity will be conducted at JPL. A detailed study plan is available and funds for the JPL support will be sent from GSFC to JPL by sub-allotment.

The primary objective of this sub-task is to develop a statistically based dual-frequency radar algorithm and to assess its performance in detail. Additionally, JPL will: (1) advise the GPM team on the Japanese radar design; (2) provide a overview of potential alternatives and

enhancements to the GPM radar design; and (3) develop a plan for calibration and validation of the GPM radar measurements.

Subtask A.3 Science Measurement Validation Planning

Planning for the validation of the GPM data is vital to developing the proper technology and enlisting the support of the science community. Validation techniques will be identified and approaches developed for their application during the mission. The validation planning will complete in August. \$xxx has been allocated to complete this subtask.

Subtask A.4 Cloud Radiation Simulation

Simulations will be developed for cloud radiation to predict its affect on precipitation measurements and clarify the mission requirements. The cloud radiation simulation subtask will complete in August. \$xxx has been allocated to complete this subtask. The GPM team will rely on analyses from both GSFC as well as grant funded activities at the University of [....].

Subtask A.5 Atmospheric Simulation & Requirements

Models of the atmosphere and the rain effects will be studied and further requirements developed. The information will be used to further refine the mission requirements in Task 2. The atmospheric simulation and requirements subtask will complete in August. \$xxx has been allocated to complete this subtask. It is currently expected that this activity will be performed at GSFC.

This sub-task will provide Level 1 GPM measurement/science requirements, as well as concise scientific rationale (OSSE results, quantitative analysis, literature references & reports, heuristic reasoning), pertaining to global and regional scale numerical weather prediction, data assimilation, and climate prediction analysis.

Subtask A.6 Climate Change Detection

An initial estimate will be made of the overall impact a comprehensive knowledge of global rainfall can have on climate change. The climate change detection subtask will complete in August. \$xxx has been allocated to complete this subtask. Currently, it is planned that the Global Hydrology & Climate Center at MSFC will perform this activity. Funding will be transferred to GHCC by sub-allotment from GSFC.

This sub-task will provide Level 1 GPM measurement/science requirements, as well as concise scientific rationale (OSSE results, quantitative analysis, literature references & reports, heuristic reasoning), pertaining to precipitation climate diagnostics, global water & energy cycle analysis, and detection of global/regional observed precipitation trends for comparison & contrast to climate model simulations of precipitation trends.

Subtask A.7 Ocean Science Requirements

A study will be performed to investigate any overlap between likely GPM science products and ocean science needs. The ocean science requirements subtask will complete in March. This subtask is unfunded.

Subtask A.8 Hydrology Requirements

Hydrology science can be derived from global precipitation measurements. The degree of connectivity with GPM should be studied to assure requirements are correctly developed. The hydrology requirements subtask will complete in March. This subtask is unfunded.

Subtask A.9 Deleted

Subtask A.10 Science Workshops & Publications

A series of science workshops and grant efforts will be undertaken to establish a forum for requirements discussion, trades, and options among the scientists and stake holders. The primary workshops will be completed by the end of May with minor follow sessions complete by August. The results will be documented and factored into Task C, Define Mission Architecture. \$xxx has been allocated to complete this subtask.

B. OUTREACH and PARTNERSHIP

The primary focus of this sub-task is the discovery of potential GPM partners, both from other US agencies and international space/research agencies. This will be accomplished with two focused efforts; the production of a partnership video (\$xxx), and the hosting of an international GPM planning workshop (\$xxx). Both efforts will be managed at GSFC, but highly coordinated with Code Y and Code IY.

The partnership video will be approximately 4 minutes long and ready for public release by May 2xxx. This effort includes the mass production of copies (September) for use by Code Y and the Science team as partnerships are continuously promoted.

C. DEFINING the MISSION ARCHITECTURE

This effort comprises four subtasks, as shown in Table 4. The schedule dates assume work starts in January xx.

TABLE 4. DEFINING MISSION ARCHITECTURE

Subtask	Sub-allocation (k)	Completion Date
C.1 Orbit Optimization and Model Development		9/30
C.2 System Concept Trade-Offs		9/30
C.3 Ground/Data System Studies		4/30
C.4 Operations Concept Studies		4/30
TASK C TOTAL		

Subtask C.1 Orbit Optimization and Model Development

The primary challenge of this subtask is to derive a method or model that will create optimized GPM orbits, given significantly constrained initial conditions (e.g. using existing satellites). This will allow the GPM team to assess the percent of global coverage and data latency times as a function of number of satellites, altitude and antenna size. It is envisioned that this effort will result in a tool that will be useful during the entire GPM mission as well as by other constellation intensive Earth Science Enterprise missions. An interim subtask report will be available in April, the completion will be in September. \$xxx has been allocated to this subtask. This effort will be performed under a task order contract to [company], the developer of [product].

This mission design analysis will be primarily for the GPM mission. The objective of this analysis is to determine the best combination of LEO missions that include several NASA, U.S., and foreign assets. There are several high level requirements and goals that must be met for mission success. These are:

1. 100% global coverage every three hours.
2. Use of limited NASA resources of less than or equal to six spacecraft in similar orbits.
3. Use of limited US resources of less than or equal to two spacecraft in predetermined orbits.
4. Use of limited non-US spacecraft, one predetermined and two whose orbit parameters will be determined by this study.

Deliverables and documentation will be produced that supports the mission architecture trades and will address the following:

- Figure of Merit of constellation designs (May).
- Reasonable and Optimized Coverage options. (Draft May, Final September)
- Analytical methods for first guess options. (May)

Subtask C.2 System Concept Trade-Offs

The various system concepts that can satisfy the science requirements will be studied and a trade-off performed to prioritize and characterize the concepts. An interim subtask report will be available in April, the completion will be in September. \$xxx has been allocated to this subtask. This subtask is further broken down into:

- Systems Engineering Support (1.5 FTE = \$XXk)
- Integrated Mission Design Center support (\$XXk)
- Product Design Center support from JPL (\$XXk)

Subtask C.3 Ground/Data System Studies

The role of the ground/data systems to support fusing GPM data from unlike sensors will be studied in this subtask and preliminary ground system requirements will be generated. In addition, a variety of implementation approaches will be examined and ranked. Participants will include TSDIS, SOMO, EOSDIS, the NewDIS Architect and the MSFC. An interim subtask peer review will be held in April, with the final report in July. \$xxx has been allocated to this subtask.

Subtask C.4 Operations Concept Studies

How the GPM constellation operations could be performed will be the focus of this subtask. Specific issues to be addressed are networking and constellation management in light of its distributed ownership. An interim subtask peer review will be held in April with the final report in July. \$xxx has been allocated for this subtask.

D. DEFINING THE MEASUREMENT APPROACH

There are many possible approaches to make the GPM measurements. This task will:

- Explore methods of obtaining the science-required measurements
- Investigate the capabilities of existing instruments
- Begin analysis of new technologies for their GPM applicability
- Examine measurement parameters, e.g. spatial resolution, antenna size, conical scan, cross-track scan, etc.
- Examine active and passive measurement techniques.
- Investigate, via the Science Team, other existing or potential sources of data, including potential new foreign sources, US Government, and commercial suppliers.

These subtasks will exploit Goddard's and JPL's extensive rainfall measuring knowledge, combined with the outcomes from the science workshops in Task 1, and complemented with requests-for-information from industry to provide commercial views.

A preliminary report will be available in May, with the task completed in September. \$XXX has been allocated for this task to cover the cost of JPL support.

E. DEFINING THE TECHNOLOGIES

There are two subtasks under Defining Technologies: enhancing technologies and technology assessment. Each is discussed in a following section.

Subtask E.1 Enhancing Technologies

At this stage, without definitive requirements the only enhancing technology that will be examined is the GSFC advanced cross-track microwave radiometer. This is currently under study by ESTO and has been awarded ATIP and IIP studies. This subtask will enable GSFC's Instrument Synthesis and Analysis Laboratory (ISAL) to study this advanced radiometer concept and will be complete in September. \$xk has been allocated for this subtask.

Subtask E.2 Technology Assessment

After the mission concepts are defined, approximately in June, an assessment will be made of all the identified viable technologies to determine their maturity. Furthermore, other NASA technology organizations, including NMP, ESTO, SOMO, JPL, and Goddard, will be contacted to assess the benefits to GPM of further technology infusion. This subtask will be complete in September. \$xxx has been allocated to this subtask to cover the cost of JPL support.

F. PROGRAMMATICS & ADMINISTRATIVE

This effort covers the on-going activity to assure the mission is planned according to GSFC and Code Y policies and is ready for an Independent Assessment in the first quarter of FY02 as well as support for Code Y budget preparation, exploration of acquisition approaches and the selection of collaboration tools. In addition, certain on-going blanket activities will be supported throughout the advanced study period. These include the organization taxes for work performed at Goddard; administrative costs for clerical support, scheduling, configuration management, and web page maintenance; and miscellaneous costs such as training, computer support, and software. The \$xxx allocated for this task has been sub-allocated to four subtasks:

- Project Planning \$ k
- Tools/ADP \$ k
- Administrative Support \$ k
- Organization Taxes \$ k